Fisheries and Oceans Science | Pêches et Océans Sciences

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Proceedings Series 2001/13 | **Série des compte rendus 2001/13**

Proceedings of the Marine Fisheries Subcommittee Regional Advisory Process Maritime Provinces

March 27 – 29, 2001

Conference Centre
St. Andrews Biological Station

K. C. T. Zwanenburg
Chair

Department of Fisheries and Oceans
Marine Fish Division
Bedford Institute of Oceanography
1 Challenger Drive
Dartmouth, NS
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102-00699

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Foreword

The purpose of this proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or mis-leading, but are included to record as faithfully as possible what transpired at the meeting. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement had been reached. Therefore, only the Stock Status Report(s), which contain the consensus decisions of the meeting, should be used as sources of information on the status of the resource assessed. Additionally, any summary on the stock status presented in this proceedings should not be referenced. The Stock Status Reports are supported by Research Documents which will be finalized from the working papers presented at the meeting.

Avant-propos

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s'est dit à la réunion. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire. Par conséquent, ce sont uniquement les Rapports sur l'état des stocks, reflétant les décisions consensuelles prises à la réunion, qui doivent être les sources de renseignements au sujet de l'état des ressources évaluées. Les brefs sommaires de rapport sur l'état des stocks présentés dans le présent compte rendu ne doivent pas non plus être considérés comme des textes de référence. Les Rapports sur l'état des stocks sont appuyés par les Documents de recherche, qui seront établis définitivement à partir des documents de travail présentés à la réunion.

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Abstract

The Marine Fisheries Subcommittee of the Maritimes Regional Advisory Process (RAP) met at the St. Andrews Biological Station (St. Andrews, New Brunswick) for the period 27 – 29 March, 2001 to review the status of the 4T and 4VWX herring populations. The remit for these reviews is given in Appendix 2. In addition to the population assessments a paper on a spatial – temporal approach to assessment of herring stocks was presented to the meeting. Stock status reports were produced for both herring stocks. The RAP editorial board subsequently reviewed these SSRs before being finalized (Appendix 6).

Résumé

Le Sous-comité des poissons de mer du Processus consultatif de la Région des Maritimes (PCR) s'est réuni à la Station biologique de St. Andrews (à St. Andrews, Nouveau-Brunswick), du 27 au 29 mars 2001, pour examiner l'état des populations de hareng de 4T et de 4VWX. La demande de renvoi à cette réunion est présentée à l'annexe 2. Outre les évaluations des populations, un document sur l'approche spatio-temporelle dans l'évaluation des stocks de hareng a été présenté à la réunion. Des rapports sur l'état des stocks ont été produits pour les deux stocks de hareng considérés. Le Conseil de révision du PCR a ensuite examiné les RES, avant que la version finale en soit produite (annexe 6).

Introduction

The chair of the meeting, K. Zwanenburg, welcomed all participants and reviewed the remit for the herring population assessments. Stock assessment documents and draft version of the stock status reports were available at the start of the meeting. External reviewers (Dr. Max Stocker - PBS, Nanaimo, Dr. Kent Smedbol – Dalhousie University, and Mr. D. Clark – St. Andrews Biological Station) did not receive copies of these documents until a day or two before the meeting. All efforts should be made to provide assessment documentation to external reviewers at least one week ahead of the meeting to allow for thorough review. In spite of this each of the reviewers made valuable contributions to the review of these assessments and the chair is indebted to them. The meeting was well served by an excellent simultaneous translation staff (Wendy Greene, Caroline Napier, and Daphne Miller-Beauroy). All meeting participants (Appendix 1) are to be commended for the respectful manner in which they conducted themselves. All discussions were constructive and participants were attentive to the opinions and discussions of their peers. The chair is appreciative of all their efforts. The meeting schedule (which was strictly adhered to) is given in Appendix 3 and the list of documents tabled at the meeting is given in Appendix 4.

4VWX Herring

Working Paper: **Melvin, G.D., M.J. Power, F.J. Fife, and R.L. Stephenson, 2001. Summary of 2001 herring acoustic surveys in NAFO Divisions 4VWX. RAP Working Paper 2001/24.**

Rapporteur: Mike Power

1. Bay of Fundy and Southwest Nova Scotia Components

Seven of 10 surveys completed

Best to date

Trinity Ledge not covered

Most fish are stage 6 which is about 1 week from spawning. Since there were two weeks between surveys there is little chance for double counting between surveys. [No data on stage distribution was presented, this should be included in the doc since this will have a major impact on the estimate of SSB

Because coverage and protocols change from year to year surveys were felt not to be comparable between years. Melvin argues that they are comparable because of consistency over the past few years. Melvin thinks that the present estimate of 450,000 t represents the best estimate of true SSB.

Roger Stirling questioned the reduction on German Bank and would like the data looked at in more detail. Max Stocker says that these are minimum estimates and the more complete recent estimates could represent a large decline in biomass. Stephenson argues against Stirling that we have a decrease in SSB with an improvement in survey methodology

Dogfish were abundant in 1999 in Scots Bay and herring were highly concentrated so this estimate may not be comparable to the most recent year.

Dick Stewart argues that the 2 week period for the survey is too long. Turnover rate (one batch of herring being completely replaced by another on the spawning grounds) is a major research question.

Don Clark argues that there are many sources of uncertainty in the estimates of biomass. It is not necessarily a minimum. Ghislain states that we judge the estimates on how well we follow the protocols etc, we need to look at other things such as year-class tracking etc. Recommend that this be done (other indicators) see previous paragraph

Q. Mean length is used to estimate target strength to convert backscatter to biomass is this appropriate? Answer the survey length frequencies (lf's) are very narrow relative to fishery lf's so this is appropriate. LeBlanc – The 4T assessment used a mean weighted target strength uses the individual length classes to determine target strength. Melvin - if the distribution is skewed then this has an impact If the distribution is relatively normal then using the mean is simpler and essentially the same as using the mean. It takes less time to use the mean.

Stirling reiterates his argument adding that 2 years is not enough to draw conclusions about increases or decreases in spawning biomass.

Sherman - fisheries change from year to year. Markets were available for juveniles so they concentrated on them. Roe fishery in 1999 had a mixture of maturities relative to higher maturities in 2000.

2. Nova Scotia Spawning Components

Most estimates during fishing activities rather than during structured surveys.

Little effort to get at spawning aggregations

This means that overage was not that good.

Weir studies showed that the acoustic estimates were always positively biased (7-14%) relative to the weigh out of the catch from the weir. Reasons - volume to weight conversion used by plant may have errors. Target strength conversion may have errors. Weir may not have been completely emptied. Tony Hooper (TH): the holds of carriers are calibrated by volume and are very accurate. It should be noted that it is hard to get all the fish out of a weir when it is seined up. It is very typical to miss 10-15% when seining up a weir.

Max Stocker Review Comments

Good collaboration between DFO and industry is positive thing. Approach by authors was ok. Questioned the comparability between years and the comparability of survey and other acoustic activities. How reliable is the conversion to absolute biomass. This is not well documented in the present paper. Transition to formal surveys is somewhat lacking.

Not convinced that the data and analysis supports the conclusions reached. On the West Coast the acoustics are used to get distribution but not very useful to estimation of abundance, they use a spawning survey to estimate the number of spawners.

Does not agree that the protocols have been consistent between years. He feels that this is not the case. Also the question of turnover rate is still outstanding and important to the overall conclusions reached. He **recommends** that the estimation of turnover rates be given high priority in future research planning.

Commented on the results of the weir studies being consistently higher than the weir weigh-out. Is the overestimate applicable to the acoustic survey results?

Description of the acoustic methods are not detailed enough [these are available in previous documents, research documents] Would help us to determine if it is an index or an absolute estimate of biomass. Gary Melvin (GM) states that we are moving toward the estimation on absolute biomass. Rob Stephenson stated that these are the best indicators that we have at present. They are quantified which is an improvement over what was used in the past. Spawn surveys (like those used on the Pacific Coast) are not feasible given the locations of spawning (60 - 70 meters deep and offshore).

GM gave a little history of why these surveys have developed as they have. Realizes that a more quantitative approach was required. They are now moving toward this quantified method. GM points out that this is only the second year of the survey.

Additional areas of research would be turnover rate and the use of these estimates as a tuning index with the VPA GM: regarding tuning of the VPA we are working towards using these surveys as an index.
Should incorporate (explicitly) the estimates of uncertainty? You should have standard error estimates for each individual year in order to determine whether there are significant differences between years or not.

Kent Smedbol Review comments

Error estimation needs to be improved for interannual comparability.

Emphasized the need for more research on turnover rates on spawning grounds.

Rob points out that there is a rationale based on industry observations which indicate that this is a good turnover estimate. Research would be to refine the estimates.

Additional Comments and Discussion on acoustic estimates

Southwest Nova Scotia Spawning Components

Rob Stephenson (RS): do these acoustic results reflect the total SSB in 2000?
GM: current approach reflects better estimation; relative scale can now be compared between recent years

Dick Stewart (DS): there were little fish (catches) on Trinity Ledge or inside St. Mary's Bay in the weirs. Are there links between these areas?

Greg Glennie (GG): What about the editing that was missed/incomplete due to time constraints?
GM: We missed only fishing nights from automated recorders on the boats and not the structured survey data. We did try to include those nights fishing identified by the fisherman as important nights where substantial amounts of fish were seen.

Roger Stirling (RS): questioned whether there is clear evidence of a reduction on German Bank from the information presented; is it real? He sees the acoustic results as being consistent over 4 years rather than up and down. Needs more evidence to be convinced of a downward trend.
Max Stocker (MS): Is 1999 considered an overestimate because of the areas missed?
GM: No, it could have been more than about 500kt in 1999 and thus and even bigger decrease is possible this year.

MS: Raised the question of a target for minimum biomass and if the objective is to maintain some minimum threshold then we need to define what they are.

Recommended that targets for minimum biomass levels be developed for each of the major spawning areas of this stock

Dan Lane (DL): the increase in Scots Bay in 2000 was what; recruitment?
GM: We haven't looked at the age structure of surveys by spawning group. The dogfish problem in 1999 resulted in not observing as much fish as the year before. This year the fish were well distributed over the area.
Don Clark (DC): Thus 1999 to 2000 Scots Bay may not be comparable?
RS: There have been more rigorous surveys and the resulting SSB has gone down. You can compare 2000 with 1999 as a result. Regarding a minimum threshold we know a lot about the history of the components. Trinity Ledge used to be as much as 40-50% of total catches but currently German Bank is the largest, Scots Bay is 2nd and Trinity is the lowest.

Allen Clay (AC): there were 2 size classes of fish noted in one of the German Bank surveys. How were these separated?
GM: the differences were identified by both the acoustic recordings and with sampling from the 2 separate areas north and south

Kirsten Clark (KC): you should remove the 1997 and 1998 data from the table if they are not truly comparable

DS: It is still a partial survey of the (German Bank) area and a conservative estimate.
GM: No, we did cover a large area, especially this year with more rigorous surveying.

DS: The fleet doesn't just fish on spawning fish with a large part of the fleet working on juveniles or in other areas. Also the turnover rate on the spawning grounds could be faster than the two weeks we are now using and would argue there is evidence of only one week. This again makes the estimate conservative.
GM: yes, the question of turnover rate is an important area of continued research.
RS: This is a minimum estimate of SSB and is consistent over the last 2 years
DC: The acoustic estimate uses target strength (T/S) to biomass conversion factor and the surveys have variance as well. You could argue the results are over or underestimates.

Ghislain Chouinard (GC): How can we better judge these surveys? They follow a proper protocol and you should look at year-class strengths and see if we can track YC's.
GM: The purpose of these surveys is two-fold 1) to be used in season to manage fishery, and 2) as an index of abundance. We have moved from semi-quantitative to quantitative estimates because the protocols are increasingly adhered to.

John Neilson (JN): is the mean length appropriate to use when applying it to a T/S, especially the skewed fishery catch at age toward age 2
GM: There was appropriate sampling from the surveys which did not survey juveniles but focused on spawning (larger) fish with a non-skewed distribution
RS: He still does not draw any hard conclusions when comparing years, even for only 1999-2000.
Claude LeBlanc (CL): could you calculate T/S by size groups or use the mean?
GM: you can use the mean as long as the length frequency distribution is not skewed

Sherman d'Eon (SD): The fish didn't show at Halifax or early in the season off southwest Nova Scotia on feeding aggregations. There were a tremendous number of juveniles in southwest NS last year (1999?). The industry initially was worried but ended up being satisfied with the amount and quality of roe fish in 2000. Did the problem of feeding early in the season affect the roe fishery?
GM: The year of low fat in 1994 resulted in being a good year-class. The survey reflects the spawning grounds for this component.

Working Paper: **Power, M.J., R.L. Stephenson, G.D. Melvin, and F.J. Fife. 2001. 2001 Evaluation of 4VWX Herring. RAP Working Paper 2001/26.**

Rapporteur: G. Chouinard

Presentation

In 2000, landings were about 85,000 t, lower than the TAC of 100,000 t. However, catches in 2000 were higher than in 1999. The allocation of the TAC is 80% for seiners and 20% for gillnets. There was a shortfall in the gillnet/weir fishery, their catches combined were the lowest on record. The fishery was well sampled with over 1,100 samples. Many samples are provided by industry. The proportion of younger fish (age 2) in the catches was higher than in previous years. This was attributed to the lack of concentrations of larger fish and a good market for smaller fish. Average weight at age declined in recent years but seem to have recovered some. The assessment was based on the biomass estimates from the acoustic surveys. The estimated biomass in 2000 is 463,000 t and lower than the estimate for 1999 of 506,000 t. Estimates for 1997-1998 may not be totally comparable because of changes in the acoustic survey methods, however, if taken at face value, they would suggest that the stock biomass has been declining over the last four years. The age composition in 2000 has not improved. It was suggested that catches in 2001 should be reduced to below 80,000 t. Basic information on the other components was presented.

Discussion

The discussion focused primarily on the Southwest Nova Scotia / Bay of Fundy component. The reasons for the shortfall in catches relative to TAC were discussed. The purse seine exceeded the allocation because a transfer from the fixed gear sector was permitted. There was a shortfall in the gillnet and weir fisheries. It was explained that the shortfall in the gillnet fishery was due to lower effort expended on the grounds. Herring gillnetters also fish lobster and the value of the lobster catches has been high in recent years.

Based on the catch at age, it was noted that the 1996 year-class seems to have disappeared and that there were few old fish in the population. Good markets for small herring (age 2) were a reason for their predominance in the catch at age. However, it appeared to be also linked to reduced concentrations of adult fish.

Some spawning areas appeared to be in lower abundance than others based on acoustic surveys. In particular, Trinity Ledge estimates were very low. Historically, this area was very important to the fishery in the area and a large proportion of catches originated from this spawning area. It was noted that one of the objective of herring management in this area is to maintain spawning areas. There were concerns that, given the low abundance, this may not be achieved for Trinity Ledge.

There was considerable discussion on the age structure of the population. The main difficulty is that it can only be inferred from the catch at age. The catch at age does not provide the best representation of the population because it does not sample consistently all

portions of the population. In particular, the apparent direction of effort towards smaller fish in 2000 was cited as an example. As a result, the abundance of age 2 herring in 2000 was considered to be unclear, although some members of industry thought that it was abundant. Because the acoustic surveys are conducted on spawning grounds, they do not provide a reliable index of recruitment at age 2, however, abundance at age from the acoustic surveys may provide a better representation of the adult population.

There was also discussion on whether the age composition, as inferred from the catch at age, has improved since the mid-1990's when the stock was considered to be at lower abundance. It was considered that the age composition had deteriorated in the mid-1990s and there had not been any significant recovery of age composition since then.

Since the assessment of the resource is largely based on the results from the acoustic surveys, there was further discussion on the estimates. The population biomass estimates are obtained by adding the biomass estimates from several consecutive surveys conducted on the various spawning grounds. It is assumed that herring arrive to the spawning ground to spawn, then leave and are replaced by a new group of fish. The current period for adding estimates from subsequent surveys (turn-over period) is a minimum of 14 days. It was noted that the period has been extended to reduce the possibility of double-counting. Nevertheless, there is still some uncertainty related to the turn-over period. It was recommended that research be conducted to evaluate quantitatively the duration of the turn-over period.

There was discussion of the completeness and methodological aspects of the acoustic surveys but it was noted that the 2000 surveys adhered closely to the protocols and were the most complete to date. There was discussion as to whether the acoustic estimates should be considered as 'minimum biomass estimates ' or as an index of biomass. The estimates are being currently used as absolute but it was recognized that they probably should be considered as an index.

During the discussion on the advice, it was noted that catches in 2000 did not reach the TAC and that despite having catches in the range of 78,000-85,000 t over the last several years, there were no signs that the stock is recovering. It was unclear whether environmental reasons were implicated in the lack of recovery of the stock. In order to promote rebuilding, catches would need to be at least lower than recent catch levels (average of about 80,000 t over last three years).

Additional Notes and Comments

Presentation of Bay of Fundy and SWNS spawning components

High proportion (26% by weight) of juveniles in the catch has not been seen since the early 1970's. This was a surprise and it was explored further.

Showed a lot of variation in age structure throughout the management unit. The 2 year olds were most prevalent in the 4Xs purse seine fishery (75% by weight) and in the 5Y portion (61% by weight).

The prevalence of 2-year-olds is significantly different from the expected age structure estimate from average recruitment and fishing at F0.1. The present age structure is significantly different with the high proportion of 2-year-olds.

Average weights at age have declined in the older fish. Mike feels that this is in the range of observations. There were some which felt that these showed a clear declining trend

Acoustics surveys good with estimate of about 460,000 t. Incomplete coverage of Trinity ledge

Last year the estimated SSB of >500 000 t and F<0.1 should have improved age composition. This year we observed a decline in SSB and a deterioration in age structure

No good spawning in any areas

Should reduce catches in 2000-2001

Need particular emphasis on Trinity Ledge

Offshore Scotian Shelf Banks

Catches primarily older fish 6+ but with very few over 8.

{Chair's note: Is this a real reflection of the age structure? This seems unlikely for a population that has not been heavily exploited since the late 1960's }

Herring are abundant and widely distributed in judging from the results of the July RV survey. However, only 2,000 t were documented by industry acoustic surveys {Chair's note : Why the big difference between the acoustic and July RV estimates?) July RV shows a large increase especially since 1997.

Need increased documentation of abundance for this component.

Coastal Nova Scotia

Spawning locations from surveys based on fishermen's memory showing that there is evidence of herring spawning all along the coast of NS. Some are now active some are not.

5th year of fishing on spawning aggregations (gillnets)

Sampling in general was poor.

In the Bras D'Or Lakes there is concern for the stock status - well sampled since they collected about 100 samples from a total landing of 69 t. No spawning in some traditional locations.

Continued concerns; no increase recommended.

New Brunswick Juveniles

Fishery dominated by age 2 (from the SA5 side)

Tagging information

37000 released from Chebucto Head 71% of 173 tags were returned from the Chebucto head fishery.

The tagging program has not had any person working on it this year. This is a problem.

Discussion of Assessment

Bay of Fundy and SWNS

More 2-year-olds were taken - Rob explains due to shift in distribution effort onto juvenile aggregation, a market for them. Second concern is that the estimate of SSB shows fewer fish, this is of concern.

Don Clark some spawning components are in good shape and some are not. Is there poor recruitment to some. Do they still have the same age structure. Age structure in the catch looks like it did in 1999. Is this a reflection on switching between populations. Mike answers that surveys will follow age structure but do not explain the large number of age 2's.

Roger Stirling - no evidence for erosion of age structure. Rob states that there may be no older fish or that there are actually a lot of two's (in addition to the markets etc)

John Nielsen: is there a lack of demand for older fish - no markets or few old fish.

Difference between catch at age and population at age. We have no estimates of the population at age [Stocker]. We have no population reconstruction. We also do not know if there is growth overfishing because we have no estimates of fishing mortalities. These are shortcomings of the assessment. No rebuttal

Question - if the fishery had moved around [instead of focussing on a single component] would the age structure in the catch have been broader. Rob says that there would have been fewer 2 year olds

Greg Glennie - says that if the 2 and 3 are combined they would not be different from the recent years.

Dan Lane - was there a discussion of 2-year-olds in last year's assessment?

Glennie there were markets for 2 year olds and that this affected age structure. Dick Stewart also indicates changes in markets (bait market---this will likely diminish given that the freezers are full). Sherman Hines states that the future is hard to predict in this market.

Delmon stated that the lack of older fish was due to a lack of fishing effort on concentrations that contained older fish.

Gary Melvin - there is no evidence for the 2 year olds being a large year-class.. Ghislain- How do we relate this observation in the catch to what is in the population.

Don C. - age structure should be great given the sampling. Which means that you should be able to estimate F on some year-classes. Can't see why we do not have more old fish if F's have been low. Ghislain - could we do a naïve catch curve analysis. What are the mortalities that would be estimated from that?

Rob feels that the catch at age by spawning ground would be a good project.

Recommended that the development of a catch at age by spawning ground be given high priority in development of research plans

Stratis - why should we believe the 500,000 t SSB. (requires a significant increase from the low stock abundance)

Overall

No evidence of age erosion, strong 2 year old year class, acoustic estimates are only two years along and not enough to draw conclusions, good news in Scots Bay, fishing below recent historical levels, improved sampling. No evidence for the recommended 20% reduction

Max- there is evidence for age erosion. Are trying to attain a good distribution of biomass by spawning ground. Question of targets. What are the objectives of this. What is the level of biomass that we want to have. Rob- there are no specific biomass targets rather we have the broader objectives of improved spawner distribution to traditional spawning grounds and an improvement in age structure. <u>But the fishery must go on during the debate as to what these levels are</u>.

Ghislain - no evidence for strong recruitment - what is the rationale for the proposed TAC? Rob says there is no number in mind. What is the catch that would meet our objectives (if we had them - they are sort of fuzzy). Rob feels that there is a need for reduction, status quo is not acceptable nor is an increase.

Stratis Gavaris says that we need an objective. Could look at a target exploitation rate. Recent catches have not allowed for rebuilding which is a target. Therefore the catches should still be lower to achieve some rebuilding. An example VPA indicated that it should be even lower than that. Do we have an objective of rebuilding?

Sherman Hines - is it justified to reduce based on estimates of minimum SSB (whole area was not surveyed). Rob said that in other years we saw 500,000t on the spawning grounds and a lot of fish in other aggregations. This year there are no other fish in the other aggregations. There is no documentation of large aggregations outside of the spawning areas.

Is there a range of uncertainty around the 465,000t estimate.(about +-25%)?

Roger states that there is evidence for rebuilding from 100,000t. But the acoustic series is not entirely comparable for the entire time series (1997 - 2000, the two that are comparable are 1999 - 2000 and they show a decline in biomass.

Sherman Hines stated that the lack of spawning on Seal Island would not be a concern since they would survey, find no fish and then not fish. Same for Trinity and Spectacle Buoy. Rob says that this is not sufficient in that we do not have spawners at all locations which is the stated objective.

Large aggregations may have been observed on the feeding grounds but there is no evidence on the table for this year. It was not recorded by industry. In the absence of documentation they can not be counted in this years evaluation of the resource. Delmon stated that they were hard to document this year. Rob states that we would expect to see large aggregations often at this level of biomass --we have no documentation of this.

Biomass has increased, age structure has improved, but these changes are not sufficient. At recent levels of exploitation we are not continuing to see improvements (biomass on all spawning areas, and expansion of age structure to more closely approximate the ideal). We are not meeting all of our stated objectives under present levels of exploitation.

Present estimates of age-structure are restricted to catch at age not population at age. This makes it difficult to gauge whether or not we are meeting or approaching these objectives.

Coastal Spawning Components (Nova Scotia)

Comments from Lloyd Robichaud and Wayne Eddy. They recommend that an egg-survey be done to determine biomass of coastal spawning components. They also recommend further work on turnover times. They considered that the fishery in 2000 had less effort than in the previous year because of effort diverted to the snow-crab fishery and because of bad weather. They recommend that all efforts should be made to collect and analyze industry collected samples.

Preliminary comments on the Stock Status Review Document for 4VWX Herring

Ghislain Chouinard- Even a reduction of just below the present landings level will not result in a significant improvement in stock status.

Sherman Hines- These are minimum observed estimates. It is possible that even with no fishery we could estimate 300,000 t next year, or with a 100,000 t fishery we could estimate 600,000 t next year. These are the vagaries of the process and our understanding of the population level

Roger states that the number is likely higher than lower. Since we cannot possibly survey the whole stock.

Rob - How quickly do we want to have the rebuilding objectives met. Recognizing that there are a number of opinions and interests. The assessment shows the direction that we have to go. Biologically speaking we should reduce significantly below 80kt. How do we achieve this?

Roger states that industry agrees that there should be a reduction. He proposes a level less than that taken in 2000 (85kt).

Trinity ledge was a large component of the population but now is not. Rob states that it should be an objective to have this spawning component back.

There are in season controls in place. These coupled with a reduction in the TAC / catches to below the average over the past few years should increase the possibility of starting the rebuilding.

Working Paper : **Lane, D., R. Stephenson, K. Smedbol. 2001. A Metapopulation Model for 4WX Herring. RAP Working Paper 2001/38.**

Working Paper: **Lane, D. S. Storey, Y. Liang. Q. Lui, X. Deng, and R. Stephenson. 2001. A Proposed Model for Spatial-temporal Assessment of the Scotia-Fundy Herring Fishery. RAP Working Paper 2001/39.**

Rapporteur : Dan Lane

Dan Lane presented two working papers on population modeling for the 4WX herring stock complex. The papers were based on Lane's work with the STABS herring research team and with graduate students in Systems Science from the University of Ottawa.

The first paper described a general metapopulation framework for exploring alternative substock structure, size, dynamics and across substock mixing and emigration. The metapopulation model is applied to the known elements of the 4WX stock herring population complex assumed to be comprised of six spawning substocks. A deterministic model and cases were presented for herring including high fidelity and low emigration cases, compared with low fidelity and high emigration cases. Other cases were presented that attempted to mimicked the current substock population components in 4WX. Selected stochastic model case results were also presented as illustrations of analyses and results that could help define further research about herring population structure and dynamics.

The metapopulation model provided the basis for a spatial-temporal model of the 4WX herring fishery (i.e., the second paper) that is designed to assist weekly management decision making in the fishery in concert with the existing acoustic methods and the "survey-assess-fish" protocol. This model uses selected model assumptions about substock dynamics in a stochastic version of the metapopulation model to generate a "core process" of the 4WX herring stock abundance dynamics in each zone and week over a season. Deviations from the "core" are described in terms of probability distributions about stock abundance. This

model uses observations from the herring purse seine fishery as repeated measures in a stock abundance updating system. Weekly observations are filtered through a reliability index that effectively translates purse seine catch, survey and potentially other ecosystem data, e.g., directly from fishermen's observations, into an update of stock abundance status.

The spatial-temporal model was presented in the form of a geographical (mapping) information system (GIS) that contained the updating and population assessment procedures using Bayesian estimation methods. The results of the model were displayed spatially on the map grids, and temporally by successive weeks of the season. It was proposed that this model be "tuned" during the coming year and form the basis for an evaluation of spatial temporal patterns of stock and substock abundance in the next (2002) 4VWX herring fishery evaluation.

4T Herring

Working Paper: **LeBlanc, C.H., G.A. Chouinard, and G.A. Poirier, 2001, Assessment of the NAFO 4T southern Gulf of St. Lawrence herring stocks in 2000. RAP Working Paper 2001/25.**

Rapporteur(s): Gary Melvin and Kirsten Clark

Ghislain Chouinard gave an introduction to the 4T assessment including an outline of the components of the Gulf herring fishery and an explanation of the way in which the TAC is distributed.

Claude LeBlanc gave a description of the 2000 fishery, the acoustic and bottom trawl surveys and results, the telephone survey and the local area acoustic projects.

Gloria Poirier presented the analytical results for these population assessments.

Discussion of the Fisheries Surveys and input data Spring and Fall Spawning Components (Notes by Kirsten Clark)

Question: Is mesh size included in the catch rate analysis?
Response: Yes. Mesh size and number of nets are calculated from the telephone survey.

Question: Why was the fall quota not caught?
Response: Market was the major reason. Fishers from Pictou, for example, only caught half their fish because the roe market was glutted. The size restrictions for the seiners in the past few years mean that fish < 25 cm cannot exceed 10% so this can make it more difficult to catch the TAC. In the mid 1990s there was a concern that too much of the fishery was in Chaleur Bay so a cap was put on that so that only 50% of the TAC can come from there. The seiners would argue that this cap might restrict them from catching the full TAC. In the past for 4Vn it has been said that the fish were too deep and near the bottom and therefore inaccessible to the seine but this year there has been little effort put into this fishery.

Question: The lack of fish in 4Vn is inconsistent with the optimism for the 4T stock. Is there an acoustic survey done there in the fall still?
Response: Not for the last 2 years. This year we have requested vessel time for such a survey.

Question: What is the basis for the quota split – historical fishing or relative size of the spawning grounds?
Response: Historical fishing.
Question: I would recommend moving towards allocation based on areas. Some groups appear to have exceeded the TAC.
Response: The global quota was not exceeded. We should be careful that individual areas do not exceed their quota.

Recommendation: The group encourages movement towards allocation based on the relative size of spawning grounds rather than historical fishing.

Question: Figure 3 of the working paper shows purse seine catches in May/June north of Cape Breton. This is the first year in recent years that this has happened.
Response: There were no observers or samples on those trips. Newfoundland seiners have a historical agreement that they can fish in 4T.
Comment: This was historically a big fishery so this should be watched. I would expect large aggregations out there, but whose are they?
Response: From 1994 to 1997, January groundfish surveys caught herring. There were a few catches on the Newfoundland side, but the vessel did not go in closer than 60 fm from shore. On the south side of the Channel there were concentrations inside 4T. We don't know what exactly the mix is between the northern and southern Gulf. **Based on other species, we would expect them to be mostly 4T fish, but this should be pursued.**

Question: How faithful are herring to spawning grounds?
Response: We believe that the fish are somewhat faithful but we are planning to do work on this. The fact that it took so long for the Magdalene Islands fishery to come back indicates faithfulness because if spawning were random, the whole 4T stock would have been lower and it would not have taken so long for the Magdalene fishery to recover.
Question: What if herring spawn as soon as they find the right temperature. The Magdalans are at the mouth of the Gulf and recent winters have been ice free, therefore the fish might spawn there since it is the first place they come to with appropriate temperatures.
Response: Then we would have seen a lot of herring at the end of the 1980s but when herring were most abundant was when the water was coldest in the mid 1990s.

Recommendation: Continued work is required to study the fidelity of herring to spawning grounds.

Question: The bottom trawl survey indicates increases in catch since 1994 but not much since. Is this a pattern?
Response: The bottom trawl survey shows a lot of variability (eg. day and night tows are mixed). It is used only to show a trend, not as an abundance index.

Comment: Since the mid 1980s there has been no trend so is there any information value to it?
Response: It is not used in the analysis but if there were no fish, it might indicate a problem.

Question: Are all removals recorded and used in the assessment – i.e. discards and other things other than catch.
Response: The removals are from Dockside Monitoring and purchase slips. Discards are not estimated. Transferring and dumping may go on but this is not estimated.

Question: Is the relationship between the CPUE and the population linear?
Response: Yes.

Question: Do you divide out your acoustic estimates into spring and fall?
Response: Yes, based on catches they are 80% fall, 20% spring. The identification of spring vs. fall is based on a GSI and, in the case of juveniles, on otolith characteristics.

Question: There is some trend in relative year classes by area?
Response: Yes, particularly in the fall.

Question: Table 8 shows the agreement between aging results. For 6+ ages, there is a tendency for the new ager to read one year younger. Figure 5 does not reflect this. Is there an error in the table?
Response: I will verify this.

Fall Spawners (Notes by Kirsten Clark)

Claude LeBlanc gave an outline of the input data for the assessment of fall spawners.

Question: There is a difference in the weights at age between the 2 gear types. Purse seine is always less, why?
Response: The gillnetters are fishing on spawning fish and the seiners on non-spawning fish.

Question: There is a trend towards a decrease in weight at age. Is there an explanation for this?
Response: No. It is seen in other species and in other areas.
Question: There is a similar decline in lengths at age. Are they not growing as much or in poor condition?
Response: We haven't looked at this in detail.
Question: Do you have a reasonable effort series? A decrease in weight at age can be induced by exploitation or environment. I don't think there has been a long term change in the Gulf.
Response: The mid 1990s were amongst the coldest in the Gulf. This phenomenon of a decline in weight at age is widespread. It could be linked to exploitation. It is currently being examined for 4T cod. For cod three factors are being studied: density dependence,

size selective fishing and temperature, and of these temperature seems to effect stock changes least.
Comment: It has implications for reproductive potential.

Recommendation: The decrease in 4T herring weights at age should be investigated further.

Gloria Poirier presented the results of the analytical assessment. Two analyses were presented, one using only the CPUE and the other using the CPUE and the Acoustic data. The first analysis was given preference.

Question: The retrospective pattern for the analysis using the CPUE only looks worse than the one for CPUE and acoustic combined. Why is the acoustic survey used in the spring assessment and not in the fall?
Response: It fits well for the spring but not the fall. Perhaps the timing of the acoustic survey is the reason.

Question: The two analyses show different trends for younger ages. What is there in the data that indicates why one model would be preferable to the other.
Response: The model used all along has been the one using just the CPUE. When you combine the CPUE and acoustic data you would expect the uncertainty to go down, but there is a slight increase instead. The retrospective for age 4 was particularly bad for the combined model and the residuals were not optimal in either case. If we had seen a decrease in the uncertainty of the estimates with the addition of the acoustics it would have been used, especially since it gives advanced warning of year classes. Once we have a long time series for the acoustics, we can see if one method is better than the other but it does not make sense to put conflicting indices together without understanding why they are conflicting.
Comment: You need a strong rationale for going with the CPUE only model. It should be noted that relying on models that assume a linear relationship between a population and CPUE has brought many stocks down so caution should be used.

Comment: The acoustic survey catches older fish. In figure 31, the age 3s are not following through to 4 from 1999 to 2000.
Response: This is another problem with the acoustic.
Comment: The 2000 catch at age for the acoustic survey shows lower levels of younger ages. Is the sampling unrepresentative or are younger fish not coming?
Response: This might support the argument for the CPUE only model.
Comment: It either supports it or if the acoustics are right, no recruitment is coming.
Response: There are a number of other indicators (good catch rates, quota easily caught, telephone survey) which show that things are not bad and that a large year class is coming. The population reconstruction is based on previous thought and there is no compelling reason to change that.

Recommendation: The difficulty in deciding between the two models should be reflected in the Sources of Uncertainty section of the SSR.

Comment: Signs pointing to something problematic should be considered. For example, the catch at age (Figure 30) shows fewer older fish.

Recommendation: Note should be taken of a lack of older fish if this trend continues next year.

Question: If you look at the VPA for the CPUE only, there are unpleasant trends in the data – 3 years of positive residuals and one year negative in the last 4 years. In Table 35a, the Fs on the partially recruited ages 4, 5 and 6 look higher than you might expect suggesting that there is a change in recruitment of these fish to the gear. Does this lead to an overestimation of recruitment?
Response: Yes, you are right.

Question: Uncertainty mostly comes from recruitment. Can there be a probability distribution of what recruitment might be?
Response: We can do risk plots for this.

Recommendation: There should be some presentation of uncertainty and wording if we do feel uncertain. Risk plots should be included.

Comment: Trends in F look like they are below the target for the last few years, however the older ages have high F's, above 0.4. These ages are well resolved and should represent fully recruited F. Ghislain response: this is why we are looking at the 4+ F. In the next assessment they should examine F and effort. The short fishery would have resulted in some reduction of F perhaps not as much as we are seeing but the relationship between F and effort will be examined

Projections - John N. - Is the pr appropriate and is the average weight appropriate. Gloria - pr derived from average F's over the past three years, the same was true of the weights. Should use the most recent weights at age. This was accepted

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Spring Spawners (Notes by Gary Melvin)

Last year - decline in catch rates were thought to have been anomalous due to a late opening, used two scenarios one using 1996 and one excluding it since the 1996 yc estimated to be large, biomass est. 80-120kt, risk analysis indicated a TAC = 15kt was more cautious.

This year - 2000 catch rates lower than in 1998 (slightly higher than 1999 the anomalous year). Acoustic index was lower, estimate of 1996 yc lower than estimated in 2000, biomass high in the mid 90's and has declined to 60-70kt, f01 around what was predicted in 2000. 12 -15kt.

Telephone survey - most areas said that the 2000 fishery was less than the year before. A general decline.

Mesh size composition has not changed.

Only 15% of spring spawners caught in the fall seine catches and a reduction in the acoustic survey.

There is no indication of a large year class other than the 1991 yc

Mean weights at age some decline but thinks that they have stabilized in the 90s. [I think that the decline is continuing].

Acoustic and cpue series give similar results of catch at age.

Why was the catch so low relative to the TAC - no clear answer.

ADAPT model results had very high cv's on the order of 50-60%

Assumed that the fraction of spring spawners in the acoustic survey represents the proportion of spring spawners in the population. Is this ok? Claude - there are no other concentrations so unless the spring spawners are elsewhere this should represent the mixture of spring and fall.

Take this proportion and estimate the amount of spring biomass from the fall biomass estimates (ADAPT), this turns out to be about 102kt Then they use VPA at various levels of F to find the one that generates this biomass.

Why, if the acoustic survey was not used in the ADAPT of fall spawner, would the proportion of spring spawners be deemed reliable?

Max - no good year-classes observed, low catch-rates, and fishers opinion is low biomass.

Kent - In the late 1990's catches were dominated by 1 year class and there is nothing coming in to replace it.

Don - Catch rate is half of what it was in 94 / 95 so it should be about half of the population at that time.

Industry reps that were present did not agree that the biomass of spring spawners is as low as we are estimating.

Telephone surveys are done after the fact (called in winter while the fishery was in summer) They say that is the problem. Also a problem with not knowing size the nets are (length)

Remove age 2 from calibration, replace age 3 in 2001 with some other low values i.e. small medium and high and take the median of each group to run risk plots.

Landings through the 1990s have resulted in declines and should be lower, maybe less than 12kt

4T Spring Herring – Summary: (Gary Melvin)
Morning Overview - Comments relate primarily to Spring spawners with a few comments on the fall fish and fishery.

Fishery 2000

- TAC exceeded for 2000.
- More effort along Cape Breton shore by seiners, no catch in 4VN.
- Acoustic survey indicates a reduction in number of spring spawners in samples from survey area.
- Fishing in St. Pauls area. NFLD boats fishing no samples. This is a change in behavior. RLS (Stephenson) suggest keep an eye on this area and the activity. Uncertainty as to origin. Is it a mix between north and southern Gulf (4T &4R).
- Question about spring spawning in Bae de Chaleur in future years. Past evidence for Southern shore but now gone. Spawning at New Mills on shore. Only the most important shown in slide. Spring spawning lower than in the past
- Allocation of effort – fixed effort could result in increased activity elsewhere (Fisherman). (GS) effort is variable due to markets, the need to control and to protect spawning components. Magedelins took almost 20 years to recover due to loyalty to a spawning area. Assumed to home to individual areas. Water temperature important to spawning but herring do not simply find appropriate water temperature and spawn. (fisherman)Will they come back to Miscou? GS we will have to wait.
- Ground fish survey – a few strata added in 1984 but index based on same strata over time.
- DC (Don Clark)– any changes in fishing gear?
- MS (Max Stocker) - Any un-accounted fishing effort in catch? None that are known.
- Check Table 8 for accuracy of ages.

Fishing mortality is low in 2000 for fall spawners - should investigate reason. Fall F suggests a major decline in effort which was not apparent in observations.

John Neilson (JN) suggests using last year's weight at age for projection.
MS wants risk plots incorporated into SSR.

Spring Spawning Component:

Fishery opened late in 1999 and fish already on spawning grounds, catch rates highest very early in the season. Catch rates may be an underestimate. Catch rate from cpue and acoustic didn't match.

For 2000 - two scenarios were examined, one with both series (CPUE and acoustics) throughout and one with cpue to 1998 and acoustics (all years). Catch rate in 2000 lower, acoustic index lower. Large uncertainties, residuals very large. Bad retrospective pattern. 1996 year-class lower than estimated. Biomass estimated depending upon scenario between 62 and 72 kt. F0.1 2001 – 12.5 to 15kt.

Claude – TAC exceeded slightly.

Spring spawners in seiner catches down from 25 to 15 in 2000 and in acoustic survey % declined by about ½ in samples. The 1991 year-class dominated throughout fishery to 1999. Still prevalent in 2000, but no sign of above year class coming into the fishery. Number of 2/3 in samples low. Slight decrease in weight at age in catches from seiners. Gillnet wt-at-age reached a plateau in last three years.

Catch rates show a declining trend with and without the Magdalenes. CPUE and acoustic indices match in general. ADAPT formulation uses both series.

Q. JN – why was seiner catch of spring fish so low? Reason unknown, possibility related to market, fish distribution and the cost of travel to grounds. Fishing does not appear to be successful in some areas.

1999 point left out of ADAPT run. Residuals are not too bad and no major difference when Magdalene Island catch rates were included. Serious retrospective pattern regardless which combination of locations are used in the analysis. Poor model fit. Used traditional approach. Partioned biomass of fall fish into spring spawners (18%) or 104kt of fall fish. Run simple vpa to generate terminal F to generate biomass of 104kt.

RLS want to know why acoustic estimates can not be partitioned and used to tune spring VPA. This is already being done Take spring biomass in survey and apply to VPA as an index.

Is the fall representative of stocks. Claude no fish found elsewhere. Herring aggregrate differently after spawning. Fall fish should be more dispersed than spring. The cv's on the VPA are in the order of 50%. Explore different approach to ascertain trend from independent method.

Don Clark - acoustic are not representative of fall population abundance; so why does it reflect spring abundance?. The approach was used some years ago and DC comment valid. Problems may be driven by age 2 . Try leaving out age 2 fish in the short time series. Nasty part or retrospective may go away.

Are we going to reject VPA? GC we know we need to decrease catches but have no idea of how much. Try Don suggestion. Have two poor estimates of the population. Difficult to arrive at F0.1. Catch rate series shows a decline. Telephone interviews suggest a decline so where do we go from here.

MS table 13 . Why is there such a major drop in the index. Major concern is 10 % drop in VPA and 75% decline in acoustic estimate. Year class recruitment very poor . Is the 104Kt too optimistic given signs.

Max Stocker suggests for presentation a summary for comparison of different scenarios. If fishing is at the target exploitation rate, why a continued decline?

KZ Would not accept VPA with cv of such magnitude. How to proceed given downward trend. How far do we go. Present catches are not sustainable. Catch level of F0.1 for 2001 is 12.5k, and is inappropriate given extent of decline.

Don Clark - catch rate is about ½ of 1994/95 at peak. Therefore, if representative then what scale we should use. Fisherman suggest decline but not to extent science believes. Some were saying there were more fish than ever. Disagreement in views. They were surprised because in December they believed that biomass would increase. However all the data were not available then and now evidence is for a decline in biomass. People reported the decline in the telephone interviews. GS tried to explain that there will be a drop recommended for catch, the question is how much.

Fishermen do not have much faith in interview in that numbers just picked out of the air. It is average. Half of the fishermen don't know the details. They feel that the figures derived from the survey are likely wrong. If there is truly a decline what is the reason. GS This is occurring is spring not autumn where things are normal. It is the view of the spring fishery that is important. Zones like Escumanic where normally people did not have trouble finding fish.

How do you know spring is smaller than fall. GS Can determine spring and fall fish. Provide best advice available. Can not control nature but can adjust catch to maintain population levels.

KZ – need to discuss how to formulate advice, direction is clear.

Max Stocker: What is the probability of exceeding F0.1 for various options. Uncertainty is addressed using risk plots. . catch at age for 2000 is not as bad. Could look at average, poor and good. Suggested poor-average rate. Rate recruitment from low to high, calculate risk. Then argue that higher levels may not be applicable. Basic decline in stock biomass since mid-nineties. May want to consider only average and low.

DC 1998 year class is not contributing to catches. So fishable biomass not affected for in next two years. Take lowest year-class from last five years. Eg 1992 year-class. Problem with age 3 in 2001. Will affect direction the population is moving.

Summary of re-analysis requested:

Remove age 2 from calibration
Divide recruitment into low/medium/high and generate risk plots for exceeding F0.1

It was **recommended** that the F0.1 level be re-calculated for this stock prior to the next assessment

Difference F0.1 for spring and fall spawners justified by difference in exploitation pattern. Use minimum from VPA to estimated recruitment for projection

JN Interruption of RV data – indices indicate negative , RV show positive. Large confidence intervals. Can only be used in general sense.

Don Clark suggestion landing as low as 12,000 have led to a decline. Recommendation should be for less if we are looking for an improvement in SSB.

Max Stocker any alternative approaches other than F0.1. Possibly ecosystem?

What about 18% scenario. Attempt to establish biomass, but is it representative of the entire population. View similar. Low exploitation rate a bit unsettling

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March 29, 2001 4vwx Herring Assessment SSR Discussion

Looks like it would be a good idea to include an index time / area for looking at weights at age for next year. This would be included in the proceedings.

Checklists by spawning component of how well the objectives are being attained. This should be added to future docs.

Ecosystem considerations should be beefed up in future.

John N. could tagging results help us in estimating M - Rob not likely given tagging mortality rates.

Research Recommendations

Impact of seal scarers on herring distribution
Turnover rates (high importance)
Establish management objectives (particularly SSB targets for each spawning component).
Age composition by spawning ground
Temperature relative to spawning and fishing
Impact of bottom trawling on spawning grounds
Estimate a time series of weights at age for an index area and time
Expansion of ecosystem considerations
Weir fishery shorter reference point (even effort)
Stock reconstruction using state of the art methodology (Stocker)
Encourage continued modeling of spatial dynamics (Lane) Should expand this into a method of assessment.

4T Fall Herring Addendum

Weights at age have been declining so take the 2000 value rather than the average of the past three years. The projection would be about 2000t less than using the average weights from the past three years.

Risk analysis (nominal) indicates that a 60,500t catch would result in about a 50% risk of exceeding f0.1. At 40kt it would be less than 10% and at 75kt it would be at about 75%.

There is no seiner cpue index. We only have cpue for inshore gillnets.

4T Spring Herring Addendum

Excluding the age 2 and 3 from the calibration did not decrease the cv's at age significantly. Used a flat topped pr at age 7.

The strong retrospective pattern observed in the original formulation remained in this analysis. Most of the retrospective is for the age 4 cohort.

If we disregard these analyses, all the remaining indices continue to show that the stock is declining.. The 1988 and 1991 year-classes are strong and there are no strong year-classes coming in behind them.

Analysis results in a 100kt biomass in the mid 90s and a bout a 50% reduction since then. This is consistent with the change in catch rates which are at about 50% of the mid 90s values.

The risk plot shows that at 12kt the risk of exceeding f0.1 is at about 50% but that it takes a bout a 25% reduction in catch to reduce this risk significantly.

Why was there no adjustment for retrospective pattern like what was done for the fall spawners? No clear answer. Thought that the retrospective pattern here was less consistent than we observed for the fall.

Comments on the 4T Herring SSR and research recommendations

Ensure that the difficulties in deciding upon an appropriate model for population reconstruction is reflected in the sources of uncertainty section of the SSR. This should include a comment on the very high coefficients of variation around the parameter estimates.

Establish a biologically based form of allocation rather than historical
Investigate the decline in numbers of older fish in the population
Determine the fidelity of herring to spawning grounds
Examine the observed decline in weights at age for the fall spawning component

Appendix 1: List of Participants

27 March 2001

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Kees Zwanenburg, Chairman	DFO, Dartmouth, N.S.	Zwanenburgk@mar.dfo-mpo.gc.ca

Appendix 2: Remit

Remit

Meeting of the Regional Advisory Process
On Maritimes Herring
27 – 29 March, 2001
Conference Centre
St. Andrews Biological Station

4VWX Herring

- Review and evaluate biological and fishery information and prepare a Stock Status Report on 4VWX herring to be used as the basis for establishing the final quota for 2000/2001 fisheries and to establish draft plans for the October 15 2001 – October 14, 2002 fisheries including:
  - A quantitative evaluation of the SW Nova Scotia spawning component.
  - A compilation and review of information regarding the offshore Scotian Shelf spawning component and the coastal Nova Scotia spawning component.
  - the following will be reviewed:

a) Coverage and results of acoustic surveys.
b) Biological basis for spatial and temporal distribution of fishing, and decision rules used in management.
c) Attributes of relevance to the conservation objectives and the precautionary approach.
d) Review of tagging and tag returns
e) Development of Biological Reference Points

4T herring

- Review and evaluate biological and fishery information and prepare a Stock Status Report on 4T spring and fall spawning herring for the July 2001 / June 2002 fisheries including:
  - Conduct a quantitative assessment of spring and fall spawners, using methods used previously (catch rate analysis and Virtual Population Analysis).
  - Provide updated 2001 / 2002 advice for spring and fall 4T fisheries, and preliminary advice for 2002 / 2003 spring and fall 4T fisheries.
  - Examine methods of estimation of biomass indices from fishery collected acoustic data including a comparison of gillnetter and purse seine data.

Appendix 3: Schedule

DRAFT AGENDA

Meeting of the Regional Advisory Process on Maritimes Herring
27-29 March 2001
Conference Centre
St. Andrews Biological Station

Tuesday, 27 March 2001

09:00-09:30	Introduction
09:30-10:15	4VWX Herring
10:15-10:30	Break
10:30-12:00	4VWX Herring
12:00-13:30	Lunch
13:30-15:00	4VWX Herring
15:00-15:15	Break
15:15-17:00	4VWX Herring

Wednesday, 28 March 2001

09:00-10:15	4T Herring
10:15-10:30	Break
10:30-12:00	4T Herring
12:00-13:30	Lunch
13:30-15:00	4T Herring
15:00-15:15	Break
15:15-17:00	4T Herring

ORDRE DU JOUR PROVISOIRE

Rencontre du Processus consultatif régional sur le hareng des Maritimes
Du 27 au 29 mars 2001
Centre de conférence
Station biologique de St. Andrews

Mardi, 27 mars 2001

9 h-9 h 30	Introduction
9 h 30-10 h 15	Hareng 4VWX
10 h 15-10 h 30	Pause
10 h 30-12 h	Hareng 4VWX
12 h-13 h 30	Déjeuner
13 h 30-15 h	Hareng 4VWX
15 h-15 h 15	Pause
15 h 15-17 h	Hareng 4VWX

Mercredi, 28 mars 2001

9 h-10 h 15	Hareng 4T
10 h 15-10 h 30	Pause
10 h 30-12 h	Hareng 4T
12 h 00-13 h 30	Déjeuner
13 h 30-15 h	Hareng 4T
15 h –15 h 15	Pause
15 h 15-17 h	Hareng 4T

Thursday, 29 March 2001

09:00-10:30	SSR Review
10:30-10:45	Break
10:45-12:00	SSR Review
12:00-13:30	Lunch
13:30-15:00	SSR Review
15:00-15:15	Break
15:15-16:00	SSR Review

Jeudi, 29 mars 2001

9 h-10 h 30	Revue des rapports sur l'état des stocks
10 h 30-10 h 45	Pause
10 h 45-12 h	Revue des rapports sur l'état des stocks
12 h-13 h	Déjeuner
13 h 30-15 h	Revue des rapports sur l'état des stocks
15 h-15 h 15	Pause
15 h 15-16 h	Revue des rapports sur l'état des stocks

Appendix 4. Letter of Invitation

Maritimes Regional Advisory Process
Bedford Institute of Oceanography, P.O. Box 1006
Dartmouth, Nova Scotia, B2Y 4A2
Tel. (902) 426-3526
Fax. (902) 426-5435
e-mail: oboyler@mar.dfo-mpo.gc.ca

14 March 2001

Distribution

Subject: Peer review of 4T and 4VWX herring stocks

The assessments of herring stocks in the Maritimes will be reviewed in the Conference Centre, St. Andrews Biological Station, St. Andrews, N.B., during 27-29 March 2001. I invite you to attend this meeting.

The objectives of peer review are: to examine the scientific approaches of the stock assessments; to identify any weaknesses in methodology; to help improve the clarity of assessments; to identify important questions that may have been neglected; and to make research recommendations. The draft agenda is attached. The meeting's terms of reference will be distributed in the near future.

The peer review includes detailed review of stock assessments and Stock Status Reports. Stock assessments will be done for 4T and 4VWX herring. Copies of the draft assessments and the draft stock status reports will be sent to the scientific reviewers one week before the meeting to allow them time to become familiar with the material. At the meeting, science staff will provide a brief overview of their assessments which should

Processus consultatif régional des Maritimes
Institut océanographique de Bedford, C.P. 1006
Dartmouth (Nouvelle-Écosse) B2Y 4A2
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Fax : (902) 426-5435
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Le 14 mars 2001

Liste de diffusion

Objet : Examen par les pairs de l'état des stocks de hareng des zones 4T et 4VWX

Les évaluations des stocks de hareng des Maritimes feront l'objet d'un examen du 27 au 29 mars 2001, au centre de conférence de la Station biologique de St. Andrews, à St. Andrews (N.-B.). Je vous invite par la présente à assister à cette rencontre.

L'examen par les pairs a pour but d'étudier les approches scientifiques aux évaluations des stocks, de mettre en évidence toute faiblesse dans la méthodologie, de contribuer à clarifier les évaluations, de traiter des éléments importants qui auraient pu être négligés et de faire des recommandations de recherche. Vous trouverez ci-joint l'ordre du jour provisoire de la rencontre. Le cadre de référence de la rencontre sera distribué dans un avenir rapproché.

L'examen par les pairs comprend une étude détaillée des évaluations de stock et des Rapports sur l'état des stocks. Des évaluations de stock seront faites pour les zones de pêche du hareng 4T et 4VWX. Les ébauches des évaluations et des Rapports sur l'état des stocks seront envoyées aux examinateurs scientifiques une semaine avant la réunion, pour leur permettre d'en prendre pleinement connaissance. Lors de la réunion, les scientifiques présenteront un bref aperçu de leurs

include: the main conclusions, the supporting evidence, any new methods, and major limitations. The presentation will be followed by comments from any of the scientific reviewers and then from any of the participants. Finalised stock status reports will be prepared at the meeting. The minutes of this meeting will be published as a procedings.

Could you please let me know at your earliest convenience if you will attending (902 426-4890 or farrellw@mar.dfo-mpo.gc.ca).

We greatly appreciate your contribution to this valuable exercise.

évaluations, qui devrait comprendre les principales conclusions, les preuves à l'appui, toute nouvelle méthode et les principales limites. Les examinateurs, puis les participants, pourront ensuite formuler des commentaires. Les rapports définitifs sur l'état des stocks seront établis à la réunion. Le procès-verbal de cette réunion sera publié sous forme de compte rendu.

Veuillez me faire savoir dès que vous le pourrez si vous prévoyez assister à la rencontre (902 426-4890 ou farrellw@mar.dfo-mpo.gc.ca).

Nous vous remercions infiniment de votre contribution à cet important processus.

R.N. O'Boyle

cc: M. Sinclair

Appendix 5. List of Documents

DFO. 2001. Southern Gulf of St. Lawrence Herring. DFO Science Stock Status Report B3-xx(2001) – DRAFT.

DFO. 2001. 4VWX Herring. DFO Science Stock Status Report. B3-xx(2001) DRAFT.

Lane, D., R. Stephenson, K. Smedbol. 2001. A Metapopulation Model for 4WX Herring. RAP Working Paper 2001/38.

Lane, D., S. Storey, Y. Liang, Q. Liu, X. Deng, and R. Stephenson. 2001. A Proposed Model for Spatial-temporal Assessment of the Scotia-Fundy Herring Fishery. RAP Working Paper 2001/39.

LeBlanc, C.H., G.A. Chouinard, and G.A. Poirier. 2001, Assessment of the NAFO 4T southern Gulf of St. Lawrence herring stocks in 2000. RAP Working Paper 2001/25.

Melvin, G.D., M.J. Power, F.J. Fife, and R.L. Stephenson. 2001. Summary of 2001 herring acoustic surveys in NAFO Divisions 4VWX. RAP Working Paper 2001/24.

Power, M.J., R.L. Stephenson, G.D. Melvin, and F.J. Fife. 2001. 2001 Evaluation of 4VWX Herring. RAP Working Paper 2001/26.

Appendix 6. Recommendations

4VWX Herring

- It was **recommended** that other sources of uncertainty in the estimates of biomass be investigated (ie. Year-class tracking).
- It was **recommended** that the estimation of turnover rates be given high priority in future research planning
- It was **recommended** that targets for minimum biomass levels be developed for each of the major spawning areas of this stock
- It was **recommended** that research be conducted to evaluate quantitatively the duration of the turn-over period.
- It was **recommended** that the development of a catch at age by spawning ground be given high priority in development of research plans
- It was **recommend** that an egg-survey be done to determine biomass of coastal spawning components. It was also **recommended** that further work on turnover times.

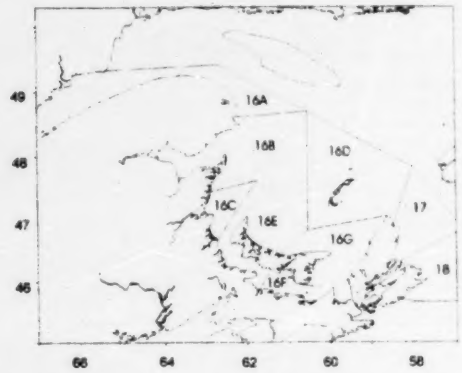
4T Herring

- It was **recommended** movement towards allocation based on the relative size of spawning grounds rather than historical fishing.
- It was **recommended** that continued work is required to study the fidelity of herring to spawning grounds.
- It was **recommended** that continued work is required to study the fidelity of herring to spawning grounds.
- It was **recommended** that the decrease in 4T herring weights at age in should be investigated further.
- It was **recommended** that the difficulty in deciding between the two models should be reflected in the Sources of Uncertainty section of the SSR.
- It was **recommended** that note should be taken of a lack of older fish if this trend continues next year.
- It was **recommended** that there should be some presentation of uncertainty and wording if we do feel uncertain. Risk plots should be included.

- It was **recommended** that the F0.1 level be re-calculated for this stock prior to the next assessment.

Appendix 7. Stock Status Reports

Southern Gulf of St. Lawrence Herring



Background

Herring are a pelagic species which form schools during feeding and spawning periods. Herring in the southern Gulf of St. Lawrence consist of a spring spawner component and a fall spawner component. Spring spawning occurs primarily in May but extends into June at depths <10m. Fall spawning occurs from mid-August to October at depths 5 to 20m. Eggs are attached to the bottom and large females produce more eggs than small females. First spawning occurs primarily at age four. The largest spring spawning populations are in the Escuminac, southeast New Brunswick and Magdalen Islands areas and the largest fall spawning population is in Chaleur Bay.

The stock area for southern Gulf of St. Lawrence herring extends from the north shore of the Gaspé Peninsula to the northern tip of Cape Breton Island and includes the Magdalen Islands. Adults overwinter off the east coast of Cape Breton in NAFO area 4Vn.

Southern Gulf of St. Lawrence herring are harvested by an inshore gillnet fleet on spawning grounds and a purse seine fleet (vessels >65') in deeper water. The percentage of spring and fall spawner component in the catch varies according to season and gear type. As a result, landings during the fall and spring fisheries must be separated into the appropriate spring and fall spawning groups to determine if the TAC for these groups has been attained. Spawning group assignment is done using a gonado-somatic index to assign maturity stage and a monthly key that links maturity stage and month to spawning group. Juvenile spawning group assignment is done by otolith shape type.

The inshore fleet harvests almost solely the spring spawner component in the spring and almost solely the fall spawner component in the fall. The purse seine fleet harvests a mixture of spring and fall spawner component during their spring fishery which occurs in the area between Cape Breton Island and the Magdalen Islands. In the fall, the purse seine fleet concentrates in Chaleur Bay and harvests a mixture of fall and spring spawner component.

TAC management was initiated in 1972. Currently there are approximately 3,500 inshore licenses and 6 active seiners (>65'). These seiner catches are restricted by the requirement that no more than 10% of the catch for any day can be below 24.5 cm fork length.

Summary

Fall spawner component

- Reported 2000 landings of fall spawner component were 59,086t against the fall spawner TAC of 71,000t.
- There were no 4T herring caught in the overwintering fishery in 4Vn. Participants in this fishery indicated that there was little effort put in searching for herring in 4Vn in 2000.
- Inshore catch rates in 2000 were equal to 1999, and these were the highest in the time series which started in 1978. The acoustic index indicated that abundance was similar to 1999. Opinions of abundance expressed during the phone survey of the inshore fleet generally indicated an increase in abundance from 1999 to 2000.

- The 1995 and 1996 year-classes are estimated to be the most abundant since 1978.
- The age 4+ biomass for 2001 is estimated to be near the highest since 1978.
- The age 7+ exploitation rate in 2000 is below the target.
- The estimated catch at $F_{0.1}$ for 2001 is 60,500t. At this fishing level, there is a 50% probability of exceeding $F_{0.1}$.
- Risk analysis indicated that to reduce the probability of exceeding $F_{0.1}$ to 25%, the catch would have to be below 51,000t. A catch of approximately 70,000t would result in a probability of exceeding $F_{0.1}$ of 75%.

Spring spawner component

- Reported 2000 landings of spring spawner component were 16,730t against a TAC of 16,500t.
- Inshore catch rates in 2000 were the second lowest since 1990. The 1999 catch rates, though lower, were considered to be an underestimate because the fishery opened after herring had arrived on the spawning beds.
- Year-classes produced after 1991 are average or below average.
- Age 4+ spawning biomass has been declining since 1995. The estimate for 2001 is 49,000t.
- The age 4+ exploitation rate was above target in 2000.
- The estimate of the $F_{0.1}$ catch for 2001 is 12,500t compared to 17,000t and 25,000t from the previous assessment.
- At a catch of 12,500t in 2001, there is a 50% probability of exceeding $F_{0.1}$.
- Risk analysis indicated that to reduce the probability of exceeding $F_{0.1}$ to 25%, the catch would have to be below 10,000t.

The Fishery

The TAC has been set separately for spring and fall spawner components since 1985. The 2000 allocation of the southern Gulf of St. Lawrence herring TAC was 77% for the inshore fleet and 23% for the seiner (>65') fleet. The TAC for fall spawner component in 2000 was 71,000t, compared to 60,500t in 1999. The allocation for 4Vn is included with the fall spawner component.

2000 FALL FISHERY
(Statistics Branch)

Area	Allocation	Landings (t)
INSHORE		
Isle Verte	426	18
Chaleur Bay	25,673	24,427
Escuminac-West PEI	8,519	10,272
Magdalen	1,776	291
Pictou	8,805	5,037
Fisherman's Bank	8,805	10,344
4Vn	710	0
Total Inshore	**54,714**	**50,398**
SEINERS (>65')		
Chaleur Bay	12,086	8,697
4Vn	4,200	0
Total Seiners	**16,286**	**8,697**
Grand Total	**71,000**	**59,086**

The 2000 TAC for spring spawner component was 16,500t compared to 18,500t in 1999.

2000 SPRING FISHERY
(Statistics Branch)

Area	Allocation	Landings (t)
INSHORE		
Chaleur Bay (Jan-June 15)	800	910
Escuminac (Jan-May)	4,100	2,262
Magdalen (Jan-June15)	1,200	3,855
Southeast NB – West PEI (Jan-May)	5,100	7,256
Bait and Roe all 4T (Jan –June 30)	1,508	1,898
Total Inshore	**12,708**	**16,181**
SEINERS(>65') (All 4T)	3,792	549
Grand Total	**16,500**	**16,730**

Percentage of Spring and Fall Spawning Components by Season and Gear Type for 2000

		Spawning Group %	
Season	**Gear**	**Spring**	**Fall**
Spring	Inshore	96	4
	Seiner	42	58
Fall	Inshore	1	99
	Seiner	15	85

Fall component landings (000s t)

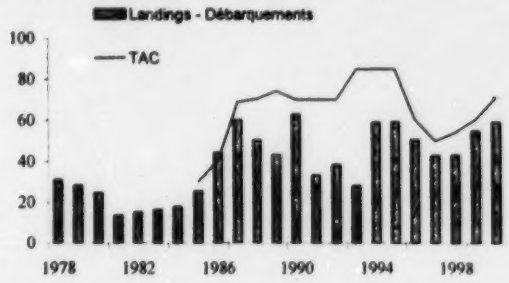
Year	Average 1987-96	1997	1998	1999	2000
TAC	73.6	54.2	58.4	60.5	71.0
Landings	52.0	42.7	43.0	53.6	59.1

Spring component landings (000s t)

Year	Average 1987-96	1997	1998	1999	2000
TAC	18.1	16.5	16.5	18.5	16.5
Landings	17.2	16.4	15.7	17.0	16.7

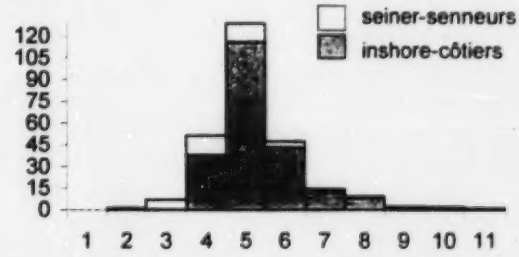
Since 1987, **landings of the fall component** have been below the TAC. Fall inshore landings are primarily driven by the roe market. The price for roe herring in 2000 was 10 cents/pound; the same as in 1999. The TAC was not reached in certain areas because the market became saturated.

4T Fall Spawner Landings and TAC (000 t)



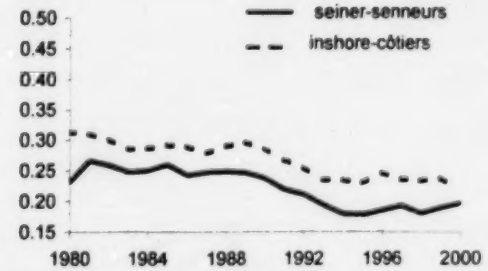
The 1995 year-class (age 5) was dominant in the 2000 catch of the fall spawner component. There were no 4T herring caught in the overwintering fishery in 4Vn. Participants in the fishery reported that little effort was put in searching for herring in 4Vn in 2000.

Fall Spawner 2000 Catch-at-Age (millions of fish)



Since 1990, the **average weights-at-age** for the fall spawner component has been below those observed during the 1980s, as exemplified by age 5.

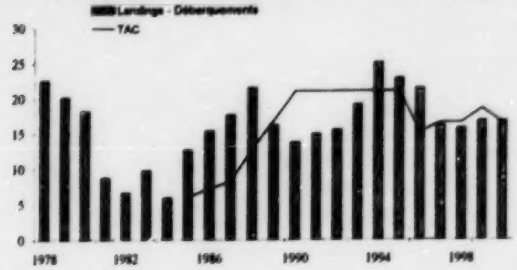
Fall Spawner Component Weight-at-Age 5 (kg)



Landings of spring spawner component were slightly above the TAC in 2000. The market for the spring fishery is different from that of the fall fishery. Spring herring caught by the inshore fleet are sold primarily for bait and to the bloater (smoked herring)

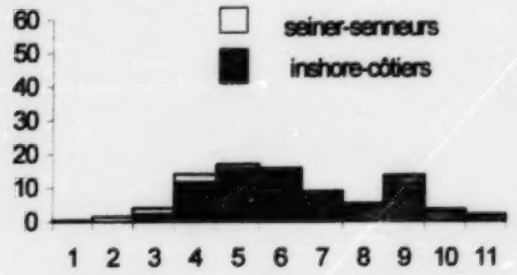
markets. The price for spring herring in 2000 was 8 cents/pound, a decrease of 5 cents/pound from 1999.

4T Spring Spawner Landings and TAC (000 t)



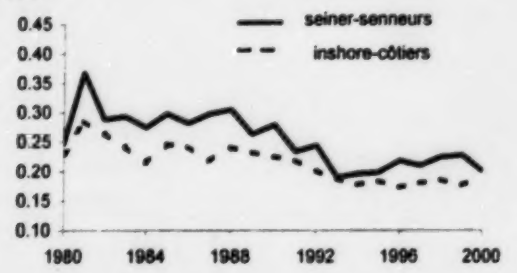
The 2000 **spring spawner catch-at-age** was composed of many age groups. The strong 1991 year-class (age 9) was still apparent in the landings.

Spring Spawner 2000 Catch-at-Age (millions of fish)



Since 1990, average **weights-at-age** for the spring spawner component have been below those observed during the 1980s. This decline in mean weights has leveled off for most ages in recent years.

Spring Spawner Component Weight-at-Age 5 (kg)



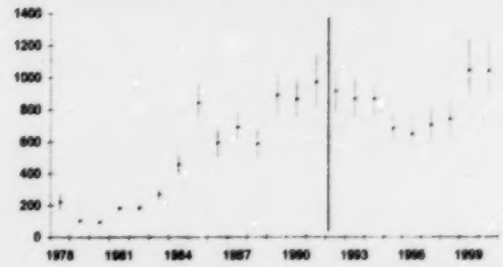
FALL SPAWNER COMPONENT

Resource Status

Resource status of 4T fall spawning herring was determined using a sequential population analysis (SPA) that combined two sources of information: the fishery catch-at-age and an abundance index derived from catch rates in the inshore fishery.

The **abundance index** used catch rate to estimate stock status based on inshore catches determined from purchase slips and effort information derived from a phone survey of 25% of the active inshore fishers. This index covers the entire inshore fleet and extends from 1978 to 2000. Catch rates in 2000 were equal to 1999, the two highest in the time series.

Fall Spawner Catch Rate (kg/net/trip)



The abundance index was split into two time periods (line in graph) for the population analysis. The time periods were (1978-1991), when a greater percentage of the inshore fleet used 2 5/8" mesh compared to the more recent time period (1992-2000), when a higher percentage of gillnetters have been using larger mesh.

The 2000 acoustic survey index indicates that abundance was similar to 1999. The estimate is near the average for the time series.

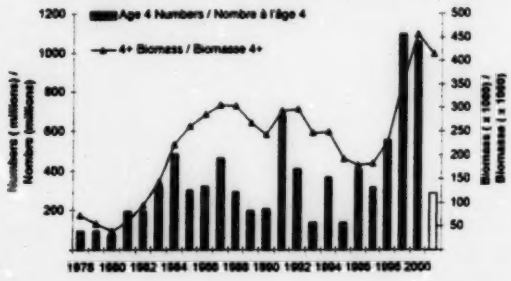
Fall Spawner Component Acoustic Survey Index (age 4+ numbers in millions of fish)

Opinions of abundance expressed by fishers during the annual phone survey of the inshore fleet indicated an increase from 1999 to 2000.

The importance of the 1995 and 1996 year-classes in the commercial fishery and the acoustic surveys suggests that the abundance of these year-classes are well above average.

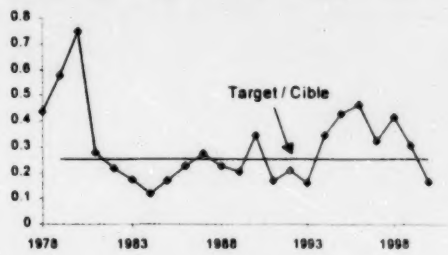
Estimated **population biomass** of age 4+ fall spawner component at the beginning of 2001 was about 415,000t, near the highest since 1978. The increase in biomass from recent years is due to the 1995 and 1996 year-classes, which are estimated to be the most abundant since 1978. The 1997 year-class was not estimated and is set at the average value over the time series.

Fall Spawner Component Stock Size



The target **exploitation rate** for fall spawner component is about 25% for fully recruited age-groups (7+). Exploitation rate has decreased over the last few years and is now below the target.

Fall Spawner Age 7+ Exploitation Rate



Sources of Uncertainty

Even with improvements in the estimates by splitting the catch rate index into two time series to account for the shift in mesh size, there still appears to be a tendency to over-estimate 4 year-olds in the most recent year. Last year's analysis indicated that the 1995 year-class was the highest in the time series. The current analysis continues to indicate that the 1995 year-class is large, but is now estimated lower than in the 2000 assessment. The 1996 year-class is estimated to be of similar abundance. The tendency to overestimate incoming year-classes at age 4 is a source of uncertainty in this assessment.

An alternative analysis that included the catch rate and acoustic survey indices was attempted. While this model was judged not as suitable as that which incorporated the CPUE alone, it provided a more conservative interpretation of population status.

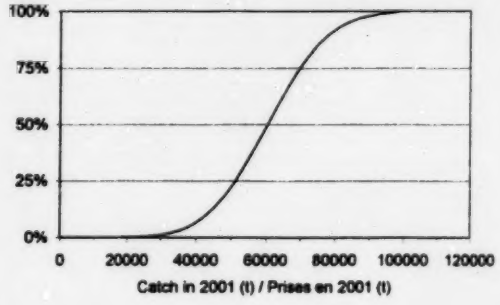
Outlook

The point estimate of the $F_{0.1}$ fall spawner catch for 2001 is 60,500t. The preliminary $F_{0.1}$ level for 2002 is also 60,500t. These levels take into account the tendency to over-estimate age 4 fall spawner component. This was done by discounting population numbers for that age group in 2001 by 15%. Since weights-at-age have been declining in recent years, the weights for 2000 were used in projections, as opposed to the average of recent years. It is estimated that the 1995

year-class would account for 39% of the catch weight in 2001. Changes in the estimate of this year-class in subsequent assessments will have a significant effect on future $F_{0.1}$ fishing levels.

A risk analysis indicated that a fishery at the $F_{0.1}$ catch of 60,500t will result in about a 50% probability of exceeding the target level in 2001. To reduce the probability of exceeding $F_{0.1}$ to 25%, the catch would have to be below 51,000t. A catch of approximately 70,000t would result in a probability of exceeding $F_{0.1}$ of 75%.

Probability of Exceeding $F_{0.1}$ for the Fall Spawning Component



In summary, the abundance of the fall spawning component continues to be high. The incoming 1995 and 1996 year-classes are estimated to be large and should support the fishery over the next few years.

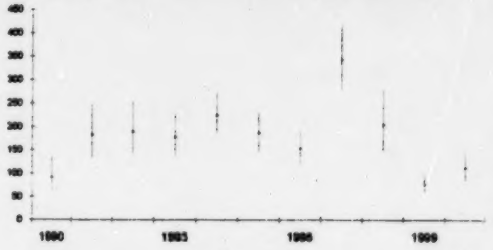
SPRING SPAWNER COMPONENT

Resource Status

Resource status of the 4T spring spawning herring was determined using a similar approach to that of the fall but included both catch rate and acoustic survey indices.

The spring catch rate analysis included dockside monitoring data from Escuminac, southeast New Brunswick and the Magdalen Islands. The Magdalen Islands data were included as landings from this fishery have increased in recent years. Effort was calculated using the average number of nets used in each area as determined by the phone survey. Catch rate was defined as kg/net/trip. The 1999 catch rate was considered anomalously low (see below). Excluding that year, catch rates in 2000 were the lowest since 1990.

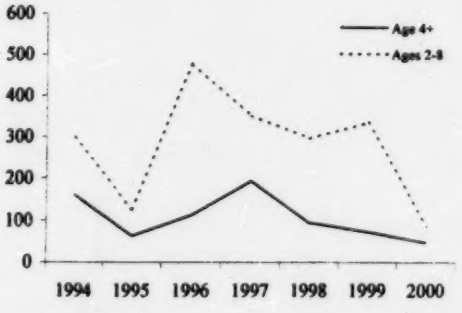
Spring Spawner Catch Rate (kg/net/trip)



Opinions of abundance from fishers (contacted in the **phone survey**) of the three main fishing areas (Escuminac, Southeast New Brunswick and Magdalen Islands) were that herring abundance was lower in 2000 than in 1999. These areas account for at least 70% of the spring inshore landings.

The 2000 acoustic abundance of the spring spawner component was the lowest in the series.

Spring Spawner Component Acoustic Survey Index (millions of fish)

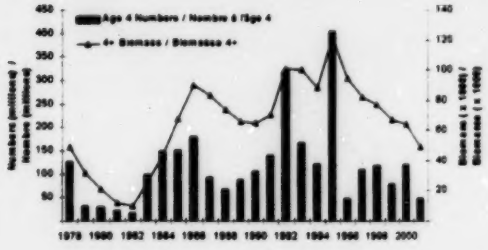


The SPA included the gillnet catch rate index and the acoustic survey index. In 1999, catch rates were the highest for the season at the beginning of the fishery, suggesting that the peak of the spawning run may have been missed. As a result, catch rates for the spring fishery in 1999 were likely biased downwards and were removed from the analysis as was done in the 2000 assessment. The analysis has a retrospective

pattern, a tendency to overestimate recent population sizes. There is considerable uncertainty about the population estimates at age.

The analysis indicates that **population biomass** of age 4+ spring spawner component peaked in 1995, when the large 1991 year-class entered the fishery as 4 year-olds. Biomass has been declining since. In the last year, population biomass has decreased below the 1990 level. The 2001 age 4+ biomass is estimated to be about 49,000t.

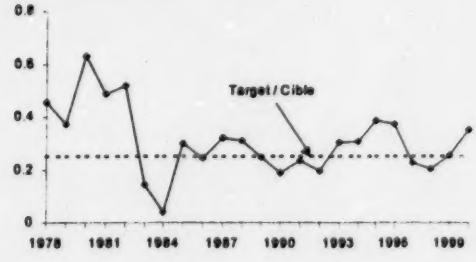
Spring Spawner Component Stock Size



Recruitment estimates from the analysis indicate that year-classes after 1991 are average or below average.

The target **exploitation rate** at $F_{0.1}$ used for spring spawner component is about 25% calculated for ages 7+. The estimated exploitation rate was above the target in 2000.

Exploitation Rates (age 7+)



Sources of Uncertainty

Population estimates for the spring component are less precise (c.v.'s of 40%-60%) than for the fall component. As well, there is a tendency for the SPA formulation to overestimate population size in the current year.

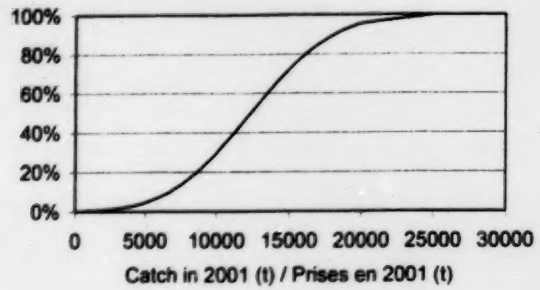
Outlook

The indices of abundance indicate a decline in stock size since the mid-1990s. In addition, the proportion of spring spawner component caught in the fall seiner fishery was the lowest observed. Also, the industry has expressed concerns regarding the abundance of spring spawner component in some of the major areas of the spring gillnet fishery.

The point estimate of the $F_{0.1}$ catch for the spring spawner component in 2001 is 12,500t compared to between 17,000t and 25,000t from the previous assessment. Thus, this assessment represents a more pessimistic view of the resource compared to 2000. The corresponding preliminary estimate for 2002 is 11,600t.

A risk analysis shows that there is about a 50% probability of exceeding the target level in 2001 at a catch of 12,500t. To reduce the probability of exceeding $F_{0.1}$ to 25%, the catch would have to be below 10,000t.

Probability of Exceeding $F_{0.1}$ for the Spring Spawner Component



In summary, views of the resource indicate that the 4T spring spawning herring stock has declined since 1995.

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References

LeBlanc, C.H., G. A. Chouinard and G. A. Poirier. 2001. Assessment of the 4T southern Gulf of St. Lawrence herring stocks in 2000/ Évaluation des stocks de hareng de la zone 4T de l'OPANO dans le sud du Golfe du St. Laurent en 2000. DFO CSAS Res. Doc 2001/045/ MPO SCES Doc de rech. 2001/045.

This report is available from the:

Maritime Provinces
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Department of Fisheries and Oceans
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Internet address: www.dfo-mpo.gc.ca/csas
ISSN: 1480-4913

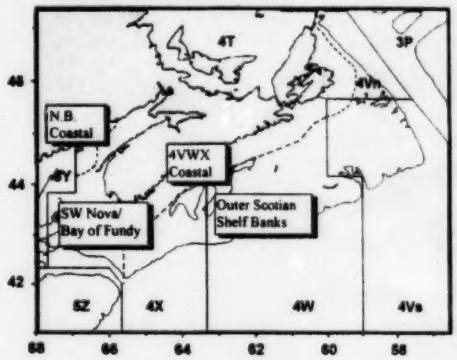
La version française est disponible à l'adresse ci-dessus.

Correct citation for this publication

DFO, 2001. Southern Gulf of St. Lawrence Herring. DFO Science Stock Status Report B3-01(2001).

P. Buerschaper
Scott & Scott 1988

4VWX Herring



Background

Atlantic herring is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations, to which they are presumed to home. Herring first mature and spawn at three or four years of age (23 to 28 cm or 9 to 11 in), then begin a predictable annual pattern of spawning, overwintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. Most fishing takes place on dense summer feeding, overwintering, and spawning aggregations.

The 4VWX management unit contains a number of spawning areas, separated to various degrees in space and time. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same complex. These undoubtedly have much closer affinity than spawning areas that are widely separated in space or time, and do not share a common larval distribution. Some spawning areas are large and offshore, whereas others are small and more localised, sometimes very near shore or in small embayments. The situation is complicated further as herring migrate long distances and mix outside of the spawning period both with members considered part of the same complex and with members of other spawning groups. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components:

1. SW Nova Scotia/Bay of Fundy spawning component
2. *Offshore Scotian Shelf banks spawning component*
3. *Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component; and*
4. *SW New Brunswick migrant juveniles.*

5. *Each component has several spawning areas, and there is mixing of fish among spawning components. Industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and of taking appropriate account of interaction among components (such as fishing restrictions on some areas of mixing).*

Fisheries in the 4VWX area in recent years have been dominated by purse seine, weir and gillnet, with relatively minor landings by shutoff and trap.

Since 1995, the herring stock assessment and related research has been enhanced by a number of projects undertaken with the assistance of the fishing industry. These include industry sampling of biological charistics of the catch and acoustic surveys using industry vessels which provide key information for the assessment.

Summary

SW Nova Scotia/Bay of Fundy Spawning Component

- Spawning stock biomass (SSB) was estimated from acoustic surveys of spawning grounds to be about 463,000t (compared to about 500,000t in 1999).

- Greater amounts of spawning fish were documented in Scots Bay, but fewer herring were recorded on German Bank than in 1999. There was no evidence of spawning on the Seal Island grounds, and the Trinity Ledge spawning group remains low.

- Recent age composition of the population has improved relative to 1996 and 1997, but still contains few fish (<2%) older than the 1992 year-class (age 8). The fishery in 2000 was dominated by juvenile herring (2 year old).

- This evaluation suggests that there has been a deterioration rather than improvement in stock status in 2000 and that the conservation objectives specified for this fishery are not being met. Catches in the year 2001 should be reduced to below that of the past three years.

Offshore Scotian Shelf Banks Spawning Component

- The 2000 herring fishery landed 2,100t, substantially less than in 1999 and the lowest in the five years of this fishery.

- Age composition from the fishery showed dominant 1993 and 1994 year-classes.

- The July bottom trawl survey continued to indicate that herring were widespread and abundant on the banks west of Sable Island.

- The initial catch allocation for 2001 should not exceed the 12,000t reference value used in the recent fishing plans.

- There continues to be the need for industry surveys to estimate abundance.

Coastal Nova Scotia Spawning Component

- Changes to management and recent research efforts have improved the knowledge of the fishery in four of the spawning areas, but there remains a lack of biological and fishery information for much of this component.

- No coastal spawning group should have a large effort increase until information is available on the biomass and biological characteristics of that spawning group. There should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

- There is continued concern for the restricted spawning distribution and low biomass of the Bras d'Or Lakes spring-spawning herring, and it is again recommended that there be no fishery on the spring spawning component.

SW New Brunswick Migrant Juveniles

- Approximately 17,000t of herring, considered to be a mixture originating primarily from NAFO Subarea 5, were landed in the traditional New Brunswick weir and shutoff fishery. This is slightly lower than in 1999. Landings were particularly low early in the season.

Objectives and Management

The 1999-2001 Scotia-Fundy Herring Integrated Fisheries Management Plan sets out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in the plan is "*the conservation of the herring resource and the preservation of all of its spawning components*" (DFO 1999).

Specific conservation objectives were developed and reviewed in 1997, and the following three objectives appear in the plan:

1) To maintain the reproductive capacity of herring in each management unit:

- persistence of all spawning components in the management unit;
- maintenance of biomass of each spawning component above a minimum threshold;
- maintenance of a broad age composition for each spawning component; and
- maintenance of a long spawning period for each spawning component.

2) To prevent growth overfishing:

- continue to strive for fishing mortality below $F_{0.1}$.

3) To maintain ecosystem integrity/ ecological relationships ("ecosystem balance").

An "in-season" management process, first implemented in the southwest Nova Scotia fishery during 1995, continued to be used widely within the 4VWX management area. The approach encouraged surveying using the commercial fleet under scientific direction prior to fishing ("survey, assess, then fish" protocol) to ensure that effort was distributed appropriately among various components of the stock (particularly among spawning components) according to the relative size and current state of each component. The use of this approach in recent years has improved data collection and enabled modifications to management decisions to be made with the involvement of participants and on the basis of up-to-date information.

Landings (thousands of tonnes)

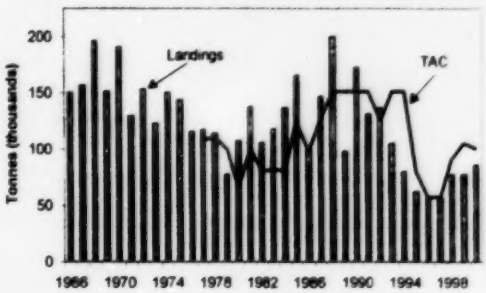
Year	1980-1989 Avg.	1990-1995 Avg.	1996	1997	1998	1999	2000
4WX SW NS TAC	106	135	57	57	90	105	100
4WX SW NS	131	115	58	56	76	78	85
4VWX Coastal NS	<1	1	2	3	4	7	4
Scotian S. Banks	<0.1	<0.1	12	20	6	13	2
SW NB	24	28	16	21	20	19	17
Total Landings	155	142	88	100	108	117	108

SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

The Fishery

The 2000 TAC for this component was established at 100,000t, a decrease of 5,000t from the previous year. Eighty percent of the TAC was initially allocated to the mobile gear sector and 20% to the fixed gear sector, as has been done historically. There was a transfer of quota of 10,000t to the mobile fleet late in the season, but this was not fully utilized due to the late date of the transfer.

Total landings from this component in 2000 (85,250t) were slightly higher than those of 1998 (78,140t) and 1999 (77,550t). Landings by the purse seine sector (83,760t) were approximately 13,000t greater than in 1999. Landings by both the gillnet sector (820t) and the Nova Scotia weirs (700t) were very small and considerably lower than in 1999. Failure to catch the quota can be attributed totally to the low catches by the fixed-gear sector.



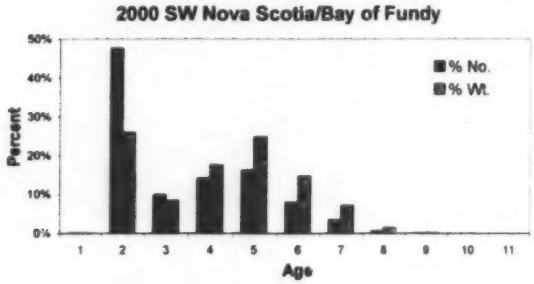
The temporal and spatial distribution of the purse seine fishery was generally as expected, but there were some changes in the relative distribution of effort. The largest purse seine fisheries occurred on the German Bank and Scots Bay spawning grounds, and on summer feeding fish around Gannet/Dry Ledge, off Long Island, N.S. and around Grand Manan. Catches in Scots Bay and around Grand Manan were considerably higher than in the previous year; while catches in the Long Island area and around Trinity Ledge were lower. In 2000, as in recent years, there was only a limited fishery for herring during the winter months in Chedabucto Bay, where during the 1970's and 1980's a larger fishery took place on over-wintering aggregations. There was a limited amount of fishing on aggregations of overwintering herring in January 2000 and 2001 off Halifax Harbour (Chebucto Head).

The gillnet fishery took place in the traditional areas (in June on the Spectacle

Buoy area and in August/Sept. on Trinity Ledge) but the decline in catch noted in recent years continued. Reduced landings in the gillnet sector were attributed primarily to reduced effort in this fishery both due to lack of market and/or price, and the success of the recent lobster fishery.

The reduced catch in the Nova Scotia weirs was unexpected. Almost no herring were taken in May and June when landings have traditionally been greatest. Few herring were taken from weirs inside St. Mary's Bay – weirs that have traditionally fished well early in the season. This is considered to have been due to a change in the distribution of herring as fish were caught throughout this period further offshore.

The 1998 year-class made up over 40% of the numbers and over 20% of the weight of herring landed. These young fish were taken primarily south of Grand Manan and mid-Bay of Fundy off the Long Island Shore. This high fraction of juvenile fish in the catch is more typical of what was caught in the 1960's and early 1970's.



Resource Status

Acoustic surveys were undertaken on the major spawning areas and in some of the major fishing areas using acoustic equipment on commercial vessels, supplemented upon occasion by research vessels. Sonars and sounders of the purse seine fleet, and sounders of the gillnet fleet were used to document the number, location and approximate size of herring schools. Acoustic recording devices allowed the logging of quantitative data for later analysis. Data were collected from structured surveys and opportunistically during many fishing trips. Survey coverage was the best in the four years this type of survey system has been used, but there was incomplete coverage of Trinity Ledge. Acoustic surveys of the spawning grounds documented approximately 463,000t of spawning herring. While there have been differences in survey coverage over the past four years, the 1999 and 2000 coverage are comparable.

Location	1997 Obs.	1998 Obs.	1999 Obs.	2000 Obs.
Scots Bay	160,100	72,500	41,000	106,300
Trinity Ledge	23,000	6,800	3,900	600
German Bank	370,400	440,700	460,800	356,400
Spectacle Buoy	15,000	1,300	0	0
Total	568,500	521,300	505,700	463,300

Surveys and fishing in 2000 confirmed the presence of large amounts of herring both on German Bank and in Scots Bay. More herring were documented in Scots Bay than in either of the two previous years, but less in other spawning areas. Almost no herring were documented on Trinity Ledge. While survey coverage of that area was poor, it remains obvious that the SSB observed at Trinity Ledge in recent years remains far below historic levels. German Bank was surveyed well in 2000, and the reduction in recorded biomass, compared with earlier years, is of concern. There remains concern over the continued lack of spawning in the traditional Seal Island area and the recent decrease in spawning at Spectacle Buoy.

Fishery information shows the presence of substantial amounts of herring in some areas other than spawning grounds. Herring were abundant on summer feeding areas off south-west Nova Scotia and Grand Manan. Substantial numbers were documented on an overwintering aggregation off Halifax in January. However, fewer herring were caught in the weir fisheries of Nova Scotia

or New Brunswick – particularly early in the summer.

Far more herring were taken at age two (1998 year-class) than was expected. This is presumed to have been due to the shift in distribution of effort to the large summer feeding aggregation, which occurred southeast of Grand Manan, the presence of markets that would accept small fish (for canned herring and for bait), and the lack of landings from weirs (on both sides of the Bay of Fundy). The relative strength of this 1998 year-class is not known. As has been noted in previous assessments, there are very few fish older than the 1992 year-class (age 8) in the catch.

Sources of Uncertainty

The evaluation of stock status in this area relies on the spawning stock biomass estimates derived from industry acoustic surveys. In recent assessments, results from acoustic surveys have been used as estimates of minimum spawning stock biomass. There is considerable variability around acoustic estimates. Standard errors around acoustic estimates from major surveys are in the range of 15-45%. Uncertainty may arise from assumptions concerning the duration of herring on spawning grounds, target strength estimates and the coverage of surveys in relation to the extent of spawning.

In the 1999 assessment, there was discussion about the fact that the SSB implied by the acoustic surveys was not consistent with biomass trends from a virtual population analysis. The biomass might have been lower than 500,000t.

There is uncertainty regarding the strength of the 1998 year-class (Age 2). Anecdotal information suggests this year-class may be large. However, if the 2000 increase in catch of age 2 fish is only a redirection of fishing effort, a greater decrease in catch may be required in subsequent years.

Ecosystem Considerations

Herring is prominent in the diet of many fish, birds and marine mammals, and should be managed with these interactions in mind. At present, use of a natural mortality rate of 0.2 and maintenance of SSB at moderate to high levels are assumed to account for these interactions.

Recent management initiatives to protect spawning components are intended to maintain the spatial and temporal diversity of herring spawning.

Outlook

This evaluation suggests that there has been a deterioration rather than improvement in stock status in 2000 and that the conservation objectives specified for this fishery are not being met. Acoustic surveys documented about 463,000t on spawning grounds, and this is less than the 505,000t documented in comparable surveys in 1999. Spawning remains well below historic levels on Trinity Ledge, and absent from Seal Island. Age composition, while improved over 1996 and 1997, remains restricted with very few fish older than 8 years of age (1992 year-class) in the population. The fishery in 2000 was dominated by 2 year olds.

In recent assessments of the SWNS/BOF spawning component, it has been suggested that removals less than 100,000t would result in fishing mortality below $F_{0.1}$ (about 20% exploitation rate), and that this would be expected to contribute to rebuilding of spawning stock biomass in all spawning areas and expanded age composition. However, there has been little, if any, evidence of rebuilding of this population in the recent past when catches have been 77,000t – 85,000t. Catches for 2001 should

therefore be reduced below that of the past three years. The greater the reduction in catch, the greater the expectation that there would be rebuilding of SSB, recovery of spawning grounds, and positive development of age composition.

Management Considerations

The in-season management approach, which spreads the effort in the fishery spatially and temporally among spawning components, is seen as beneficial in achieving the objectives related to maintaining spawning potential. The "survey, assess, then fish" protocol is effective in spreading the catch appropriately among spawning components in proportion to their relative size and is considered an important safeguard at this time of uncertainty and concern regarding stock status.

Acoustic surveys have become critical to stock status evaluation. Where surveys occurred in 2000, they conformed well to the proposed survey pattern. It is important that there be continued attention to coverage and survey design, in order to develop year-to-year consistency in these surveys, as has been proposed.

OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

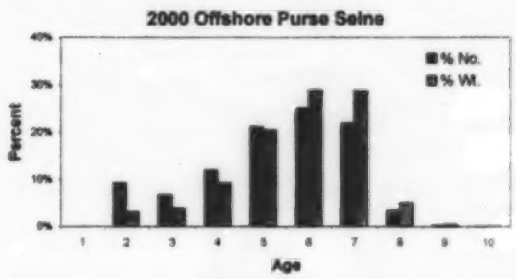
The Fishery

A foreign fishery during the period 1963-1973 is estimated to have removed as much as 60,000t per year from the offshore Scotian Shelf banks. There had been few herring caught after the extension of jurisdiction in 1977 until 1996, when a fishery was initiated by the 4WX purse seine fleet and 11,745t was taken.

The 2000 fishery on Scotian Shelf Banks was smaller than in recent years, with landings amounting to a little over 2000t. Fishing took place primarily in June, in the vicinity of The Patch. The maximum amount of herring documented in acoustic records from fishing vessels working in the area was about 1500t on June 19.

In 2000, there continued to be a by-catch in the domestic bottom trawl fishery on the Scotian Shelf edge and slope, but the amount was considerably less than in 1999.

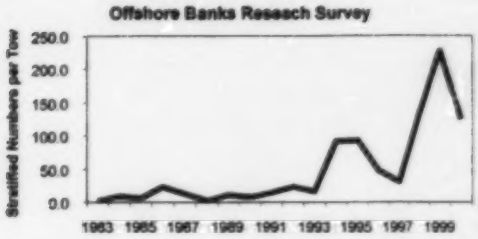
The catch was dominated by 1993 and 1994 year-classes (ages 6 and 7). The same year-classes were dominant in 1999.



Resource Status

Previous results from the summer bottom trawl survey showed few herring on the Scotian Shelf during the 1970's, increasing amounts during the 1980's and a relatively widespread distribution in recent years.

Offshore herring catches during the 2000 July bottom trawl survey were the third highest in the 31-year time series with an average of 124 fish per standard tow. While catches of herring in the survey were considerably lower than in 1999, survey results of the past three years have been the three highest values on record (and in the 18 years in which the same vessel and gear have been used). As in recent years, herring were widely distributed on banks west of Sable Island.



A research vessel acoustic survey of the eastern portion of the Scotian Shelf Oct 20-28 documented approximately 2000t of large herring (mean length 31.5cm) on southern Western Bank.

Outlook and Management Considerations

The results of the annual summer bottom trawl survey demonstrate that there is a considerable abundance of herring, widely spread over the offshore banks of the Scotian Shelf in July. The information from previous assessments indicates the presence of at least some autumn spawning on Western Bank in recent years. There is very little new information to add and no reason to change the previous recommendations that:

- Landings in the foreign fisheries of 13,000t to 60,000t between 1969 and 1973 did not appear to be sustainable.
- The initial catch allocation for 2001 should not exceed the 12,000t reference value used in the recent fishing plans.

There continues to be insufficient documentation of stock size, distribution and spawning behaviour for this component. Industry, Science and Management are encouraged to continue to work together to improve the biological basis for management. There continues to be the need for industry surveys to estimate abundance.

COASTAL (SOUTH SHORE, EASTERN SHORE AND CAPE BRETON) NOVA SCOTIA SPAWNING COMPONENT

The Fishery and Resource Status

There has been an increase in the number of active gillnet licenses in recent years. This was the fifth year for a fishery on spawning fish east of Halifax and the fourth year of gillnet roe fisheries off Little Hope and Glace Bay.

Recorded landings in the four major gillnet fisheries along the coast of Nova Scotia (4,280t) were lower than in 1999 and approximately the same as in 1998.

East of Halifax

The roe fishery in September and October had landings of 1350t. Sampling was very limited, but indicated that the catch was composed primarily of 1992-1994 year-classes (ages 6-8). Acoustic surveys undertaken by Eastern Shore Fishermen's Protective Association on four nights in October resulted in an SSB estimate of 10,870t.

Little Hope

The fishery occurred in the Little Hope area in September and October. A total of 2,040t of herring was landed. An estimate of 5,200t SSB was made from an automated acoustic recorder used during the fishery. No samples were taken for biological analysis.

Glace Bay

The fishery off Glace Bay, Cape Breton took place in September and October. Landings were 830t. Fish aged 7 (1993 year-class) and age 8 (1992 year-class) dominated the catch. There were no surveys.

Bras d'Or Lakes

The fishery was technically closed, but a limited number of fishers were allowed to set nets for samples and could retain catches. Fishing was underway by the last week of March and ended the first week of May, 2000. Effort was concentrated (by regulation) outside of spawning areas. Landings were approximately 60t.

The 1993 year-class (age 7) and 1992 year-class (age 8) dominated the catches. Sampling demonstrated that for most of the fishery, the catch was composed primarily (90%) of autumn spawners. Spring-spawning herring made up only a small fraction of herring caught in several areas that had in the past been known spawning areas (including Groves Point, Malagawash). In only two areas (Baddeck Bay, Eskasoni Harbour) was there evidence of substantial numbers of spring spawners.

Spatial herring surveys undertaken in mid April documented less than 70t of spring spawners.

Outlook and Management Considerations

Since 1996, there has been development of the inshore fisheries in Glace Bay, East of Halifax and Little Hope, primarily for roe. As these fisheries have developed, participants have contributed to sampling and surveying – and the fisheries have attempted to follow the 'survey, assess, fish' protocol. The results of the fisheries in 2000 demonstrate that there needs to be better coordination of surveys and sampling.

This management approach and recent research efforts have improved knowledge in these three areas, but there has been little advancement in knowledge in adjacent areas. The lack of knowledge on the specifics of stock structure, lack of documentation of the historical fishery, and limited survey information preclude evaluation of current fishing mortality for much of this component. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size and proximity to shore. As in the past four years, it is recommended that no coastal spawning area should have a large effort increase until much more information is available on the state of that spawning group. There should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern. The information gathered in 2000 does not indicate improvement. Spawning is still absent from some traditional areas and the observed biomass of spring spawners is very low. For the fourth year it is therefore appropriate to advise that given continued deterioration in signals from the Bras d'Or Lakes fishery it is preferable, from a biological perspective, that no fishing take place on this spawning component.

In coastal Nova Scotia, there is no overall quota, and the size and historical performance of various spawning groups are poorly documented. In addition to traditional fisheries for bait and personal use, there are new directed roe fisheries on the spawning grounds. The "survey, assess, then fish (<10%)" protocol is considered useful for spawning components that are considered to be healthy and of sufficient size, but is not practical for all coastal spawning groups.

SW NEW BRUNSWICK MIGRANT JUVENILES

The southwest New Brunswick weir and shutoff fishery has relied, for over a century, on the aggregation of large numbers of

juvenile (ages 1-3) herring near shore at the mouth of the Bay of Fundy. These have traditionally been considered to be a mixture of juveniles, dominated by fish originating from NAFO Subarea 5 spawning components, and have therefore been excluded from the 4WX quota. Mature herring (ages 4+) taken in this fishery are considered to be of 4WX origin.

The number of active weirs and distribution of weirs has decreased over the past decade, due in part to the conversion of sites to aquaculture, as well as the reduction in landings over the past decade in the Passamaquoddy Bay area. The 2000 catch of 16,830t for N.B. weir and shutoff gears was a little lower than in 1999. Landings were particularly low early in the season, with almost no weir landings in May and June.

The 2000 catch was dominated by the 1998 year-class (age 2), which made up over 75% of the catch by number and by weight.

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ISSN: 1480-4913

La version française est disponible à l'adresse ci-dessus.

Correct citation for this publication

DFO, 2001. 4VWX Herring. DFO Science Stock Status Report B3-xx (2001).